STORAGE OF PROJECTED PRESENTATIONS

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] The present invention relates in general to digital data storage, and in particular to capturing digital data from a live presentation. Still more particularly, the present invention relates to a method and system for converting transmitted rasterized data into a format suitable for storage in an application software format.

2. Description of the Related Art

[0002] Many live presentations are made using a laptop connected to a beam projector or large screen monitor. For example, **Figure 1** depicts a system in which a computer **102** sends image data via cable **104** to a digital projector **106** for projection onto a screen **108**.

[0003] The display projected by digital projector **106** is analogous to the display of a cathode ray tube (CRT) monitor or a liquid crystal display (LCD) monitor. The monitor (or projector) displays a sequence of horizontal lines made up of many points called pixels. This sequence of horizontal lines is called a "grid" in an LCD monitor or digital projector, and is called a "raster" in a CRT monitor. The complete sequence of horizontal lines is rapidly scanned to avoid flicker.

[0004] File data stored in computer **102**, such as file data from a PowerPoint™ file, is first converted into a stream of data that controls each pixel in a projected display. When in this form, the stream of data is referred to as being "rasterized."

[0005] Often, after a live presentation, many in the audience ask for a copy of the material that was presented. Such a request is relatively easy to fulfill if the presentation was solely a showing of a PowerPoint™ or similar file. That is, the presenter only has to send the requester a floppy disk or e-mail attachment with the presentation, assuming the presenter remembers the request and still has the requester's contact information.

[0006] However, if the presentation displays images from a non-computer digital data source, such as a digital camera, memory stick reader, etc., or if the presentation is of images that are not stored on the computer, such as a presentation from another computer or passed-through streaming audio or video data from the Internet, then making a copy of the presentation to send to the requester becomes difficult, if not impossible.

[0007] Furthermore, a presenter might manipulate a canned program during the presentation, making a saved program file different from the presentation. That is, while showing a PowerPoint™ program, the presenter may skip over a slide that is inappropriate for his audience, or may use a mouse pointer to draw attention to a part of a photo or drawing while discussing that slide. If the requester were only to review the original stored PowerPoint™ program, any additional information given by the presenter would be missing from the stored program.

[0008] Thus, what is needed is a method and system that permits capturing rasterized digital data and storing that data into a known file format that is easily communicated to another party. Preferably, the system would capture previously stored image data, as well as real-time manipulations of the image data. It would also be beneficial if such a system provided an easy way to send the captured image data to a requester.

SUMMARY OF THE INVENTION

[0009] In view of the foregoing, the present invention provides a method, system, and program product supporting capturing real-time digital image data that is in rasterized form. A digital source sends rasterized data to a storage device, which passes the rasterized data to a display device. The rasterized data is then converted into a page format, such as PowerPoint™ formatted slides, based on changes in the rasterized data. If the data changes quickly enough, the storage device converts the rasterized data into a motion picture format. Otherwise, the rasterized data is stored as a single static frame image. According to one preferred embodiment, the storage device is directly connected to a network, such that a file formed from the converted rasterized data is sent to a requesting party as an e-mail attachment.

[0010] The above, as well as additional objectives, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further purposes and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, where:

[0012] Figure 1 depicts a prior art system in which a computer sends image data via a cable to a digital projector for projection onto a screen;

[0013] Figure 2 illustrates the inventive system having a storage device for capturing rasterized digital data being transmitted from a digital source to a display device;

[0014] Figure 3 depicts a computer system used as an exemplary digital source;

[0015] Figure 4 illustrates additional detail of a graphics sub-system in a computer system;

[0016] Figure 5 depicts an exemplary disk drive storage device used by the present invention;

[0017] Figure 6 illustrates additional detail of an interface in the disk drive storage device;

[0018] Figure 7 is a flow-chart of an evaluation of a format of digital data received at the disk drive storage device;

[0019] Figure 8 is a flow-chart of a determination of whether digital data is to be stored as a single frame file or a multi-frame animated file; and

[0020] Figure 9 is flow-chart describing capturing cursor movement over a static single frame.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0001] The present invention discloses a system for storing manipulated rasterized image data. As shown in **Figure 2**, such a system **200** includes a digital source **202** sending rasterized image data to a storage device **204**, which stores the image data in a converted format and also passes through unconverted rasterized image data to a display device **206**. In a preferred embodiment, storage device **204** is connected to a network **210** via a network interface card **208**, allowing a file stored in storage device **204** to be communicated directly to a user device (not shown) connected to network **210**. System **200**, and particularly storage device **204**, is described in detail below.

[0002] With reference now to **Figure 3**, an exemplary digital source is depicted as computer system **300**. Computer system **300** includes a CPU **310**, main (physical) memory **311**, and disk storage **312**, interconnected by a system bus **313**. Other peripherals such as a keyboard **314**, a mouse **315**, and a network interface adapter card **326** for interface to a network **317** are included in the computer system. A graphics subsystem **402** is connected to CPU **310** and memory **311** via a bridge **325**, a PCI bus **319** and a bus interface **320**.

[0003] Graphics subsystem **402** includes a rasterizer **321** that generates pixel data for a bit-mapped image to be displayed. The bit-mapped image is stored in a frame buffer **322**. The data stored in the frame buffer is read out via a Random Access Memory and Digital-to-Analog Converter (RAM-DAC) **323** to a cathode ray tube (CRT) display **408** as an analog signal **316**. Alternatively, if the display is a digital display **406**, such as a digital monitor or a digital projector, frame buffer **322** sends a digital signal **318** to a digital display **406**. In either case, the frame buffer **322** is bit-mapped to the screen of the display, each pixel of the display having a corresponding location in frame buffer **322** storing a definition of what is to be displayed for each pixel during a raster scan. This definition includes color, intensity, etc., and usually contains reference to palettes or tables for expanding the information to be displayed for the pixel.

[0004] In order avoid tying up busses **313** and **319**, and using too much of CPU **310**'s time, rasterizer **321** generates most of the pixel data to be stored in frame buffer **322**. CPU **310** generates graphics primitives that describe what is to be displayed in a higher-level or more abstract expression, and these are transferred via busses **313** and **319** and interface **320** to rasterizer **321**, which generates the pixel data. The bandwidth used by the output of rasterizer **321** is much greater than that of busses **313** and **319** for video data. For example, a 1024x1024 pixel color screen refreshed 50/sec., with 24-bits per pixel, requires a bandwidth of 150-Mbytes/sec. Thus, busses (not shown) downstream of rasterizer **321** operate at this speed to convey screen data. A much lower bandwidth is needed for transfers over busses **313** and **319**, in supporting the graphics subsystem from CPU **310** and memory **311**.

[0021] **Figure 4** illustrates additional detail of graphics sub-system **402**. Graphics sub-system **402** includes rasterizer **321** and frame buffer **322** as well as a cursor logic **410** and a color palette **412**. As introduced above, rasterizer **321** takes high-level commands from software running on an associated CPU, such as CPU **310** in **Figure 3**, and generates pixel data for display. Pixels are written to frame buffer **322**. Cursor logic **410** generates hardware cursors and overlays, commonly referred to as "sprites", for display on a selected digital display **406** and/or CRT display **408**. Palette **412** generates pixel color information. In a preferred embodiment of the present invention, the sprite generated by cursor logic **410** is incorporated into data in frame buffer **322** to produce a single frame image for display (combining both the main display as well as the sprite overlay).

[0022] Pixel data generated by rasterizer **321**, cursor logic **410** and palette **412** are input to either RAM-DAC **323** or a digital display driver **427**, according to a control signal from a display selector **430** to multiplexer (MUX) **428**. If the pixel data is sent to and converted to analog data in RAM-DAC **323**, then that analog data is sent to CRT display **408**. If the pixel data is sent to a digital display driver **427**, then the pixel data remains digital and is sent to a digital display **406**.

[0023] **Figure 5** is a block diagram showing a disk drive storage device **204**, as shown in **Figure 2**, according to a preferred embodiment of the present invention. Storage device **204** preferably has a magnetic disk **511** (disk storage medium in either hard or floppy format) as a data record

medium, and a magnetic head **512** for reading/writing data from/into the magnetic disk **511**. The storage device **204** also has an actuator mechanism **513** for moving a slider which carries the magnetic head **512** to a particular position over a surface of the magnetic disk **511**, a voice coil motor (VCM) **514** for causing an access arm of the actuator mechanism **513** to swing, and a VCM driver **515** which includes a spindle motor for causing the magnetic disk **511** to rotate and drive the VCM **514**. The storage device **204** further has a read/write circuit **516** for controlling a data read/write operation, which contains a module including an amplifier circuit for a detection signal, a waveform shaper, an analog-to-digital converter (ADC), a digital-to-analog converter (DAC). The storage device **204** also has a hard disk controller (HDC) **517** for controlling the data read/write operation from/into the magnetic disk **511**, a RAM **518** for temporarily storing data fed thereto and caching data to be recorded into the magnetic disk **511** and data reproduced from the magnetic disk **511**, a microprocessor unit (MPU) **519** for controlling an operation of the entire HDD inclusive of the HDC **517**, a ROM **520** for storing microprograms and data to operate the MPU **519**, and an interface (I/F) **521** which is connected to digital source **202** through a bidirectional line. The digital data that is provided to I/F **521** is either the digital pixel data from digital display driver **427**, or is reconverted digital data from the analog pixel data from RAM-DAC **323** that has been reconverted into digital data by an analog-to-digital converter (ADC), which is not shown.

[0024] The VCM driver **515** includes a 9-bit digital-to-analog converter (DAC), which converts a digital control signal from the MPU **519** into an analog control signal and transmits it to the VCM **514**. The HDC **517**, the RAM **518** and the MPU **519** are connected to each other through a data bus. Further, the HDC **517** is connected with the MPU **519** through a control bus, and is connected with digital source **202** through the I/F **521**.

[0025] The magnetic disk **511** may be of an embedded servo (i.e., a sector servo) type in which a disk surface has concentric and circular tracks each containing both data regions in which data is recorded and servo regions in which servo data is previously recorded, or of a servo surface servo type in which one of the disk surfaces of the magnetic disk is for servo use only, while only data is recorded on the other disk surface.

[0026] Magnetic disk **511** has a plurality of concentric and circular data tracks, each of which includes n LBAs (logical block addresses), where n represents an arbitrary positive integer. The magnetic disk **511** is formatted so as to include a first track having a predetermined number of first sequential LBAs, a second track having a predetermined number of second sequential LBAs which immediately follow the first sequential LBAs, and at least one track disposed between the first track and the second track. The HDC **517**, the RAM **518**, the MPU **519**, the ROM **520** and the I/F **521** as a whole operate to control the operation of the entire HDD, and constitutes a controller **522** which controls a data input from digital source **202**. The controller **522** includes the MPU **519**, which executes a control program, a memory that stores data such as the control program and a defect map indicating locations of defective sectors, and other components. The memory includes the RAM **518** and the ROM **520**, and the control program is stored in the ROM **520**, for example. While data stored in the ROM **520** can be read at a high speed, there is a limitation on the capacity of the ROM **520** because of packaging technology and cost reduction. Accordingly, a portion of the control program which cannot be stored in the ROM **520** may be saved in a given region of the magnetic disk **511**, and may be read out from the magnetic disk **511** and written into the RAM **518** upon power on reset (POR) for execution of the control program. Further, the RAM **518** has a function of a cache memory having a storage capacity on the order of data of several hundreds of record units (i.e., sectors) on the magnetic disk, for example, 128 KB (256 blocks).

[0027] The controller **522** controls the operation of the entire HDD by executing the control program (microprogram), controlling a write operation with respect to the magnetic disk **511** on the basis of commands stored in MPU **519** and data which is fed from digital source **202** through the I/F **521**. The MPU **519** of the controller **522** is capable of executing a plurality of processes in parallel. One of these processes relates to a manipulation of data from digital source **202**, as discussed in detail below with reference to **Figure 6**. Another is a write cache process in which the write data saved in a buffer (RAM **518**) is written into the magnetic disk **511**, and a further one relates to a seek control in which the magnetic head is brought substantially radially over the magnetic disk **511** to be positioned on a particular one of the tracks. In addition, the MPU **519** is capable of executing processes such as arithmetic operations for the servo control, an error recovery process and the like in parallel.

[0028] Although storage device **204** is depicted as a hard disk drive, it is understood that in the preferred embodiment of the present invention, storage device **204** may be any secondary storage device, including a floppy disk drive, a read/write compact disk read only memory (RW-CDROM), a Zip drive, etc.

[0029] As mentioned above, MPU **519** also controls the function of I/F **521**, which is now discussed as shown in more detail in **Figure 6**. As digital data from digital source **202** is received at I/F **521**, an input evaluator **602** first determines whether the digital data is rasterized video data or a program file. That is, in the preferred embodiment of the present invention, it is presumed that the digital data from digital source **202** is rasterized video data. However, there is a possibility that the digital data may be a file, such as a PowerPoint™ file, which is already assimilated for storage, and thus is sent directly to the HDC **517** for storage. But if the digital data is rasterized video digital data, then the input evaluator **602** sends that rasterized data to a buffer **604**, where the data is combined with other rasterized data if the rasterized data is a moving video, or is directly sent to a data converter **606** if the rasterized data is a single static video frame. The multi-frame or single frame pages of video are then sent to a file assimilator **608** for assimilation into a file format appropriate for storage under the control of HDC **517**.

[0030] I/F **521** may also receive an audio input from an analog audio source **610**, such as an amplified microphone. If so, the audio input is either converted into an audio digital file by MPEG converter **616**, or is converted into written text by **614**, according to routing by MUX **612**, before being sent to file assimilator **608**. In a preferred embodiment of the present invention, each audio file, whether in an auditory MPEG file or written text, is associated with the appropriate video page, whether that page be a single frame or a multi-frame moving image. Thus, each page has an audio script that can be heard (MPEG) or read (text conversion) with the page, whether that page is a single slide or a moving picture clip.

[0031] With reference now to **Figure 7**, there is depicted a flow-chart of data storage to storage device **204**. Data is received at storage device **204** from digital source **202** (block **702**). If the digital data is in a high-level program format (block **704**), such as PowerPoint™, then it is stored as such (block **706**). If the digital data is rasterized video digital data, it is first converted into a

high-level program format (block **708**) before being stored. The process continues until a decision is made to stop (block **710**).

[0032] Determining how to store each page of video data is depicted in **Figure 8**. Starting with block **802**, a frame of data is received in buffer **604** (**Figure 6**), after being determined that the data is rasterized digital video data by input evaluator **602**. A decision is then made to determine whether the incoming data is part of a single page having animation (moving pictures), or is a single page having only a single static image. That is, a moving picture is simply a stream of static images sent to a display quickly, to provide animation. If a different frame is received (block **804**) in buffer **604** within a predetermined amount of time, such as within 1/20 second, then the first and second received frames are assumed to be part of a moving animated image, and are stored together as multiple frames of a same page (block **810**). Subsequent frames are also stored if received within the next predetermined amount of time (since the last frame was received) and are ultimately stored as a single MPEG file (blocks **812** and **814**).

[0033] If a subsequent frame is received after the predetermined amount of time, then the first frame is stored as a JPEG file for storage as a single image, and the buffer **604** is cleared of the first frame (block **806**). The process continues until a decision is made to terminate the storage of the rasterized images.

[0034] As noted above, each page may have an associated audio track, which is stored either as text or an MPEG file for later hearing/reading by the requester of the presentation.

[0035] In a preferred embodiment, cursor movement is also captured and stored by the present invention. Referring now to **Figure 9**, a static single frame is captured as described above (block **902**). Cursor logic **410** shown in **Figure 4** detects whether there is cursor movement over the static single frame (block **904**). If so, then the static single frame and the cursor movement are combined together to create an MPEG animated image (block **906**).

[0036] The present invention therefore provides an efficient method and system for capturing rasterized video digital data and converting that data into a file format for storage and sharing. The rasterized video digital data is source independent, being only raster data formatted for projector or monitor display. Thus, a presentation may include various digital data sources, and still be captured as a single program. That is, the presentation may switch back and forth between various programs files (such as different PowerPoint™ files), on-line and off-line sources, etc., and yet with the present invention the total presentation is captured and stored. Once stored, the file formatted data can be sent via the Internet to a requester, or can be saved to a removable medium (floppy disk, read/writable CD-ROM, etc.) and given to the requester.

[0037] It should be understood that at least some aspects of the present invention may alternatively be implemented in a program product. Programs defining functions on the present invention can be delivered to a data storage system or a computer system via a variety of signal-bearing media, which include, without limitation, non-writable storage media (e.g., CD-ROM), writable storage media (e.g., a floppy diskette, hard disk drive, read/write CD ROM, optical media), and communication media, such as computer and telephone networks including Ethernet. It should be understood, therefore in such signal-bearing media when carrying or encoding computer readable instructions that direct method functions in the present invention, represent alternative embodiments of the present invention. Further, it is understood that the present invention may be implemented by a system having means in the form of hardware, software, or a combination of software and hardware as described herein or their equivalent.

[0038] While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.